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ABSTRACTS FROM ASTRONOMICAL PUBLICATIONS.

In accordance with a recent arrangement the members of the scientific staff of the Lick Observatory hold meetings once per week, as an observatory duty, to report upon and discuss the more important articles appearing in the journals of astronomy, the important new books on astronomical subjects, or subjects of current and special interest in the observatory's work. It has been suggested that abstracts of the reports would be of interest to the readers of these *Publications*, and the Publication Committee has acted favorably upon the suggestion.

It is intended to preserve the qualities of abstracts as far as possible, and to restrict published criticisms, favorable or unfavorable, to a minimum.

THE LINES OF MAGNESIUM.[1]

The spectrum of magnesium has recently been investigated by Professor FOWLER at the South Kensington Laboratory, London, with a view to find series among the lines analogous to those of hydrogen. His previous investigation of the hydrogen spectrum as given by a vacuum arc led to the production for the first time in the laboratory of the sharp series which before had been found only in *Zeta Puppis* and similar stars; also to the discovery of a second principal series and of four members of the first principal series, the first of which corresponds to the line 4686 found in nebulæ and Wolf-Rayet stars. It seemed then that hydrogen was unique in having two principal series converging to the same limit of frequency like the diffuse and sharp series. It is now found that the magnesium spectrum from the vacuum arc contains at least one pair of series converging to a limit of frequency. This pair of series is in the violet and ultra-violet, and another is suspected in the visual region to correspond with the diffuse and sharp series of hydrogen. Just as the first line of the first principal series of hydrogen 4686 is a conspicuous stellar line, so the first line of the first of the two new magnesium series is a conspicuous stellar line in classes A and B. Professor FOWLER measures the wave-length on his plates as 4481.35. It is a strong line in the spark spectrum of magnesium. It is as strong as helium in many early-type stars. FROST and ADAMS determined its wave-length from their stellar plates to be

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[1] By A. FOWLER. South Kensington, London, *Proceedings of the Royal Society*, **89**, 133, August, 1913.

4481.40. A significant result of Professor Fowler's measurements is the practically constant difference of frequency of about a thousand units between each line of the new magnesium series and the corresponding line of the principal series of hydrogen.

The well-known Rydberg series of single lines given by the arc in air are very diffuse. Fowler has found them quite sharp in the vacuum arc and has obtained more accurate measures of their wave-lengths. Three of these lines in the blue region were known to correspond to solar lines. The succeeding four toward the violet are now seen to correspond with solar lines, so that it is very certain that the Rydberg series of single lines exists in the solar spectrum. Professor Fowler finds that three other lines seem to be associated with the Rydberg series somewhat as the sharp series of hydrogen is associated with the diffuse series, but the correspondence is not exact. The following table give the measures of the several series investigated:—

First Fowler.	Second Fowler.	First Rydberg.	Second Rydberg(?).	Rowland Solar.
4481.35[1]	3104.91	....	5711.56[2]	5711.31
2661.00	2449.68	5528.75[2]	....	5528.64[3]
2329.68	2253.94	....	4730.34	4730.21
2202.75	2166.35	4703.33[2]	....	4703.18[3]
....	....	....	4354.53[5]	5354.43
....	....	4352.18[2]	....	4352.08[3]
....	....	4167.55	....	4167.44
....	....	4057.78	....	4057.67
....	....	3986.94	....	3986.90
....	....	3938.58[4]	....	3938.55
....	....	3904.17[4]	....	....
....	....	3878.73[4]	....	....
....	....	3859.39[4]	....	....

[1] Strongest line in magnesium spark and strong in early type stars.
[2] Measures by Kayser and Runge.
[3] Previously identified with magnesium.
[4] Discovered in the vacuum by Fowler in the present investigation.
[5] Predicted by Fowler from his formula and at once found on his plates.

The discovery in the laboratory of stellar lines and the determination of their wave-lengths is of great help in determining the radial velocities of stars and in dealing with the questions of the physical condition of stellar masses and their atmospheres as regards their temperature, pressure, density, intrinsic luminosity, energy, radiation, character of spectrum, whether emission, absorption, or both of these with the phenomena of reversal. The conditions under which lines appear in the laboratory may give an indication of the stellar condition of the star in which they are found with similar characteristics. FOWLER's investigations, therefore, lend great aid to astrophysics.

G. F. PADDOCK.

FLEXURE OF MIRRORS: EFFECT UPON RESOLVING POWER.[1]

This investigation is an attempt to deal with the effect of the bending of a mirror upon the image which it may form. A brief statement of the problem and attending conditions is as follows: Resolving power is proportional to aperture. Distortion of the figure due to weight of mirror and form of support will impair the resolving power. Increasing apertures for mirrors of same thickness and same form of support may gain no resolving power. There may be a critical aperture beyond which resolving power may decrease. The object of the paper is to calculate the distortion for various forms of support and the effect on resolving power and the limits of aperture permissible. The difficulties of analysis permit the consideration of only simple forms of support, but they are sufficient to show whether the critical aperture is beyond the limit of practicable construction.

The analysis is based upon the equations of elastic equilibrium in the theory of elasticity. The horizontal and vertical positions of the mirror are treated, the inclined position being considered a combination of the other two. The back supports considered are those at the center, at the rim, and on a circle between center and rim. The formulæ first deduced give the relative depression of center and rim or of any point of the radius with respect to the fixed center or rim. Further formulæ deal with the breadth of the image of a point source of light and the effect upon it of the flexure of the mirror; whence follow expressions for the limit of aperture beyond which the breadth of the image decreases the resolving power. Assuming the thickness to be one tenth the aperture, the limit of aperture is eight inches for support at the circumference; for supports at both center and rim, the limit is about four feet; for supports at center, at rim, and midway between, the limit of aperture is about ten feet. By increasing the thickness of the mirror, the limit of aperture is increased, but the thickness may be determined by the process of casting the glass, the homogeneity of the glass, and the amount of weight feasible to support. It is obvious that more complete back supports than those mentioned increase the limit of aperture beyond practicable sizes of mirrors. Further discussion of the distortion in the plane of the morror, due to inclined or vertical positions, shows that it is impossible to prevent displacements tangential to the rim, but the normal displacements can be prevented by rim supports. On the vertical position, assuming the focal length to be five times the aperture, the limit of aperture is about twelve feet. By increasing the focal length the limit of aperture is increased.

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[1] By H. S. JONES, Cambridge, *Proceedings of the Royal Society*, 88, 494, July, 1913.

The conclusion reached is that with simple forms of support the critical aperture is greater than is practicable for construction. An example of the best system of support is that of the Mount Wilson 60-inch mirror, which has well-distributed back supports and a rim band with lateral supports.

G. F. PADDOCK.

ON A SIMPLE METHOD OF DETECTING DISCONTINUITIES IN A SERIES OF RECORDED OBSERVATIONS WITH AN APPLICATION TO SUN-SPOTS.[1]

Professor TURNER has been engaged for some time in analyzing WOLFE's sun-spot numbers in a Fourier sequence, "arriving finally at the conclusion that none of the periodicities disclosed were continuous throughout the series." In the present paper, he resumes the discussion, beginning by describing a simple expedient for detecting the breaks in such a series. The method followed is exhibited in a detailed application to WOLFE's numbers from 1749 on, which reveals discontinuities or breaks in the series, not introduced by the calculation and hence existing in the observational data. "These breaks are near the dates 1766, 1796, 1838, 1868, 1895, which are sufficiently close to those of *Leonid* perihelia to suggest a *vera causa.*"

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[1] By H. H. TURNER, *Monthly Notices R. A. S.*, **74**, 82, 1913.

Before discussing this hypothesis the author exhibits a table to show varying periods which best fit the sun-spot numbers. These are as follows: 1749-1767, 10.9 years; 1760-1796, 9.379; 1787-1838, 12.49; 1829-1870, 11.69; 1860-1894, 12.07; 1890-1911, 13.39.

The remaining portion of the paper is devoted to an exposition of his hypothesis that the *Leonid* meteor swarm is responsible for these discontinuities, or changes of period in sun-spot activity.

The *Leonids* cannot act directly, since the perihelion distance of the stream is about an astronomical unit; hence a secondary swarm is postulated. This swarm is assumed to revolve in about eleven years, with a very small perihelion distance, comparable to the Sun's radius. The major axis of the orbit is nearly five astronomical units, and the eccentricity is exceedingly high, $e = 1 - .001$. Hence, on any ordinary sized diagram, the orbit would be practically a straight line, resting one end on the Sun, with the other extending 10 A. U., approximately *Saturn's* distance, from the Sun. In such an orbit the velocity at the Sun end would be very great, at the other very small; hence the swarm would linger at aphelion, four fifths of the period being spent at a distance greater than 5 A. U. from the Sun, and half the period at a distance exceeding 8.5 A. U.

In this part of the orbit the swarm will be very sensitive to perturbations, and it is suggested that the *Leonid* swarm is the disturbing agent. This assumption is then investigated in detail, the perturbing effect of the *Leonids* on the swarm as it moves out toward aphelion and, later, when it returns, being taken into account.

Professor TURNER finds that by plausible assumptions of the relative positions of the hypothetical swarm and of the *Leonids,* the observed variation in periods can be explained.

The origin of this hypothetical swarm is then considered and the hypothesis is advanced that it is a portion of the *Leonid* swarm which has been detached by an encounter of the *Leonids* with *Saturn.* From a consideration of the periods of *Saturn* and of the *Leonids,* it is found that the year 301 A. D. "seems most promising" for this encounter, tho there are also arguments in favor of the year 271 A. D.

The author admits that "the foregoing theory depends on the fundamental assumption that the *Leonids* have sufficient mass to alter the period of the SSS [sun-spot swarm] very considerably. If so, they must also be able to perturb appreciably other bodies near which they pass, and particularly the Earth." The unexplained fluctuations in the Moon's motion are then examined and the conclusion is reached that they are quite consistent with disturbances at *Leonid* returns.

Professor TURNER further thinks it possible that the *Leonids* may be responsible for the unexplained secular movement of the perihelion of *Mercury.*

Finally, he finds no difficulty in accounting for the "equatorial acceleration" of sun-spots.

At the time of making this abstract no critical comment on Professor TURNER'S hypothesis has been printed.

February, 1914. R. G. AITKEN.

PHOTOGRAPHIC METHODS IN LATITUDE WORK.

Most of the attempts which have been made in the past to employ photography in the investigation of the variation of latitude have failed to prove their superiority to visual observations. But a decided advance appears to have been made in this field by the recent work of Dr. F. E. ROSS at Gaithersburg, Maryland, with a photographic zenith telescope of special construction.[1] "By a suitable mechanism the photographic plate is made to move in an east and west direction with the speed of a zenith star. Six images, of 14 seconds exposures each, are secured of each star, three before and three after reversal of the objective. The objective is 20^{cm} (7.87 inches) in diameter and has a focal length of 516^{cm} (20.31 inches). Stars of magnitude 8.5 can be photographed on an average night. The maximum zenith distance measurable is 10′." The accuracy of the results secured is very high; the greatest deviation from the mean of all Dr. ROSS'S observations in one month was 0″.20, and there was only one error of this magnitude. The probable error of one pair of stars is ± 0″.061, while the corresponding probable error of the same observer by the ordinary visual method, derived from observations extending over several years, is ± 0″.102.

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[1] *Astronomische Nachrichten,* **197**, 137, 1914.

H. D. Curtis.

A Faint Companion to Capella.

An interesting discovery has been made by Dr. R. Furuhjelm of Helsingfors Observatory, from measures made on plates of the Helsingfors section of the *Carte Photographique du Ciel.* He finds that a faint star of photographic magnitude 10.6, slightly over twelve minutes of arc from *Capella,* is physically connected with the bright star. The faint star has almost precisely the same proper motion as *Capella,* both in direction and in amount. As *Capella* is itself a spectroscopic binary, the discovery of this distant companion adds additional interest to the system.

The special interest of the discovery lies in the relatively very great distance of the faint companion from the bright star. Adopting Elkin's value for the parallax of *Capella,* its distance from our system is roughly forty-one light-years, and the faint companion star is at least one-seventh of a light-year, or over eight hundred billion miles from its bright primary.

H. D. Curtis.